Claims

1. Method for determining the spatial position of wheel rim to a measuring unit, that includes at least one camera, wherein the wheel rim lies in the viewing field of the camera, including:

making available of a model that describes a model body of a localizable wheel rim geometry detail as well as the spatial position of the model body to the measuring unit through model parameters,

capturing of a picture of the wheel rim geometry detail of the wheel rim with the camera,

fitting of the picture of the model body resulting from the model parameters to the picture of the rim geometry detail through changing the model parameters of the model, and

tracking the changes of the model parameters of the model upon the fitting, whereby

the data related to the position of the model body of the wheel rim geometry detail reflect the spatial position of the wheel rim geometry detail and, thereby, of the wheel rim itself, when the image resulting from the model parameters of the model body of the wheel rim geometry detail matches to the captured picture of the wheel rim geometry detail within the asserted tolerance limits.

2. Method according to claim 1, characterized thereby that the model body is a so-called osculating torus or a 3D-CAD representation.

3. Method according to claim 2 characterized in that, in case of the osculating torus, model parameters of the model are a primary radius R and a secondary radius r of the torus, a position c of the torus center, a normal vector n of the plane of rotation of the torus and a position z of the projection center of an aperture camera, with which the osculating torus is viewed.

4. Method according to one of the claims 1 to 3, characterized in that the wheel rim geometry detail is the shadow border line of the rim edge contour.

5. Method according to claim 4, characterized in that

the shadow border line is captured by at least one camera; that

from the shadow border line an extreme shadow border line curve is calculated; that

from the extreme shadow border line curve an axes is calculated through an orthogonal projec-

tion, which axes is perpendicular to a plane spread out by the wheel rim, whereby the position of the wheel rim in space is determined.

6. Method according to claim 1, characterized in that the wheel rim contour is captured with two cameras which are directed to the wheel at different angles.

7. Method according to claim 1, characterized in that the picture of the wheel rim is used for determining an angular rotation reference point on the rim.

8. Method according to claim 7, characterized in that, for determination of the rotation angle-reference point on the rim, the position of a characteristic feature on the wheel is used.

9. Method according to claim 8, characterized in that, as a characteristic feature for determination of the rotation angle-reference point, a characteristic feature on the rim is used.

10. Method according to claim 8, characterized thereby that, as characteristic feature for determination of the rotation angle-reference point, an air valve of the wheel is used.

11. Method according to one of the claims 7 to 10, characterized in that, for segmentation of the perimeter of the rim, a pre - segmentation and a fine segmentation is carried out.

12. Method according to claim 11, characterized thereby that, in addition to the pre - segmentation and fine segmentation a sub - pixel segmentation is carried out.

13. Method according to claim 1, characterized thereby that the fitting of the image of the model body of the wheel rim geometry detail to the picture of the wheel rim geometry detail through alteration of model parameters of the model is done thereby that, at first, an approximation of a rim edge plane, then an angle argument calculation and lastly a final torus model fitting on the final rim edge plane is carried out.

14. Method according to claim 1, characterized in that the data with respect to the model parameters of the model which define the spatial position of the wheel rim when the image of the model body

of the wheel rim geometry detail fits to the captured picture of the wheel rim geometry detail, are output or displayed.

15. Method according to claim 1, characterized by the following steps:

starting the picture shooting;

segmentation of the rim wherein a segmentation of the air vent of the motor vehicle is carried out;

segmentation of the rim edge in order to measure the asserted angle range of the rim edge;

reconstruction of the 3-D position of the rim edge;

displaying the results of the calculation, namely of the normal vector and of the central point of the rim edge plane and/or storing of the same for the further calculation.

16. Method according to claim 15, characterized in that the position of a characteristic feature is reconstructed while considering the outer camera parameters in order to obtain a parameter set "axis of rotation", that is the true axis of rotation with respect to the normal vector.

17. Method according to claim 15 or 16, characterized in that, after the start of the picture shooting, it is examined at first whether the illumination is sufficient for the measurement, and that the illumination is adjusted accordingly.

18. Method according to claim 15 or 16, characterized in that the adjustment includes a larger or smaller intensity of the light for the illumination.

19. Measuring unit for determining the spatial position of a wheel rim to a measuring unit that includes at least one camera, wherein the wheel rim lies in the field of view of the camera, characterized by a computer which is programmed to execute the method according to one of the claims 1 to 16.

20. Measuring unit according to claim 19 for execution of the method according to claim 6, characterized in that two cameras are provided which capture the perspective picture of the wheel rim contour and are directed to the wheel under different angles.

21. Measuring unit according to claim 19, characterized in that each camera includes an optical

sensor, an objective, an aperture setting unit and a focus setting unit, and that the mounting position of the sensors and of the objective, the aperture setting and focus setting are pre - adjusted.

22. Measuring unit according to claim 20 characterized in that, in case of Zoom – objectives, furthermore the set focal length is pre - adjusted.

23. Measuring unit according to claim 21 for execution of the method according to claim 14, characterized in that an output or display system, respectively, is provided for outputting or displaying, respectively, the data with respect to the model parameters, which define the spatial position of the wheel rim, when the image of the model body of the wheel rim-geometry detail fits to the captured picture of the wheel rim geometry detail.

24. Method for the wheel alignment measurement on motor vehicles, characterized in that

the method according to one of the preceding claims is executed on the wheels of the motor vehicle, that

the relative positions of the measuring units for execution of the measurements are determined,

that the measuring results of the measurements on the wheels of the motor vehicle are expressed in terms of wheel position values taking into account the relative positions of the measuring units , and that

the wheel position values are output or displayed.

25. Method according to claim 24 characterized in that the relative positions of the measuring units for the execution of the measurements are fixed through an adjustable mounting of the measuring units on a measuring site.

26. Method according to claim 25, characterized in that the relative positions of the measuring units for execution of the measurements are determined through a reference system that is arranged between the measuring units.

27. Method according to claim 24, characterized through the following steps:

execution of the measurements of the individual measuring units;

entering of the measuring results into a computer;

calculation of the transformation matrix from the results of the reference system measurement;

transforming the result vectors of the measuring units into the arithmetic coordinates system through offset angles and distances from the reference measuring system;

determination of the wheel position values in the arithmetic coordinates system through evaluation of the position of the result vectors to each other for calculation of the corresponding wheel alignment measurement values;

presenting of the results to the wheel position angle values to a display system and/or storing of the same for further use.

28. Wheel alignment measuring system for motor vehicles, characterized by measuring units according to one of the claims, which measuring units are positioned on a measuring site in such a manner that a measuring unit each is associated with one of the wheels of the motor vehicle whereby the relative positions of the measuring units are determined during the execution of the measurements, a computer which processes the measurement results of the measurements on the wheels of the motor vehicle to wheel position values taking into account the relative positions of the measuring units, and by an output - or display unit which outputs or displays the wheel position values.

29. Wheel alignment measuring system according to claim 28, characterized in that the relative positions of the measuring units for execution of the measurements are fixed through an adjustable mounting of the measuring units at a measuring site.

30. Wheel alignment measuring system according to claim 28, characterized in that the relative positions of the measuring units for execution of the measurement are determined through a reference system, that is arranged on the measuring units.

31. Wheel alignment measuring system according to claim 28, characterized in that, upon combined assembly of two cameras in a measuring unit for a stereo-measuring system, the cameras are calibrated with respect to the coordinates system of the measuring unit.